

Prioritization of Water Resources Inventory Assessments (WRIA) and 6 Year Plan for Region 8 Refuges

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Executive Summary

The goal of the WRIA is to perform an inventory to compile a baseline, standardized inventory of Refuge water resources features, information, and data and to assess the status of water resources at each Refuge and make recommendations on water resources needs to best meet Refuge goals and objectives.

Regional management have requested that a prioritization process be developed for Region 8 for development and completion of WRIAs that best meet Regional priorities and focus on Refuges where water resources issues are most critical. A ranking system was developed to prioritize WRIAs for Refuges based on determining goals and objectives for successful and efficient development of WRIAs for Refuges. Refuges were ranked to receive a WRIA by how well they met the following goals and objectives:

Refuge has a need for a WRIA (maximize need): WRIAs should be prioritized towards Refuges that have significant water resources issues that affect the ability of the Refuge to carry out management objectives.

- Greater severity of water supply and quality issues, complexity of water entitlement issues, and highly vulnerable to climate change
- Refuge staff requested a WRIA, assistance with understanding water rights, and assistance with hydrologic monitoring

Region 8 I&M should focus first on refuges in which the WRIA is easier to conduct (minimize difficulty): to improve efficiency and make greater progress toward completion with limited staff resources and time.

- Breadth and complexity of water supply sources, water quality, water entitlements, and water management issues are minimal
- Refuge water rights or water policy issues are relatively stable
- Refuge has easily accessible hydrologic monitoring data
- Refuge has well organized and well documented water information

The needs and difficulty objectives were trade-offs (for example, a Refuge with complex water resources issues needs of a WRIA, but is also difficult to complete); there was a correlation between need and difficulty. We identified Refuges that are in the top third scores for greatest need. Among those Refuges, we prioritized those Refuges that were the least difficult to complete.

Based on results of this ranking, Region 8 I&M selected the following 12 refuges for prioritized completion of WRIAs in the next 5-6 years:

- 1.) Sacramento, Delevan, and Colusa NWRs (Moderately difficult)
- 2.) Stillwater NWR (Moderately difficult)
- 3.) Upper Klamath NWR (Moderately difficult)
- 4.) Butte Sink WMA (Moderately difficult)
- 5.) Stone Lakes NWR (Moderately difficult)
- 6.) Lower Klamath and Tule Lake NWRs (Moderately difficult; Tule Lake NWR has moderate need)
- 7.) San Luis and Merced NWRs (Very difficult; Merced NWR has moderate need)
- 8.) San Joaquin River NWR (Very difficult)

Introduction

Water Resources Inventory and Assessments (WRIAs) are reference documents for ongoing water resource management and strategy development. The long term goal of the National Wildlife Refuge System (NWRS) WRIA effort is to provide up-to-date, accurate data on Refuge System water quantity and quality in order to acquire, manage, and protect adequate supplies of clean and fresh water. WRIAs focus on a large scope of hydrologic issues at every Refuge, including water rights and policy, climate, climate change, surface water and groundwater availability and dynamics, wetland management, Refuge water infrastructure, and water quality.

The USFWS National Water Resources Team (WRT) has recommended an inventory and assessment of Refuge water resources (as well as Fish Hatcheries) in order to prioritize issues and tasks, and recommend resources needed to take prescriptive actions to protect Refuge water resources. WRIAs are recognized as an important part of the Refuge System Inventory and Monitoring (I&M) Initiative and are outlined in the I&M 7-year workplan (U.S. Fish and Wildlife Service 2013).

The Region 8 Inventory and Monitoring Program (I&M) is supporting development of WRIAs because the objectives, tasks, and products are consistent with I&M goals and objectives. The primary objectives identified by the Region 8 I&M Initiative related to water resources include (U.S. Fish and Wildlife Service, 2013a): providing water supply information to improve decision making (Objective 2.6), improve access to high quality hydrologic data to improve decision making (based on Goal 1), and understand impacts of climate change: Assess the exposure and vulnerability of Refuges to climate change (Objective 2.8).

The first goal of the WRIA is to perform an **inventory to compile a baseline, standardized inventory of Refuge water resources features, information, and data**. This inventory will provide necessary baseline information for an assessment of what is known and unknown regarding the Refuge's water resources, identify critical data gaps, and to be used as guidance for future monitoring to help achieve Refuge management objectives. This inventory will collect a standardized set of existing baseline information, including descriptions and links to data including but not limited to: geospatial information, water rights or other supply entitlements, water quantity, water quality, and water management. This information will eventually be stored in a national Water Resources Inventory and Assessment Database.

The second goal of the WRIA is to **assess the status of water resources at each Refuge and make recommendations on water resources needs, including monitoring, to best meet Refuge goals and objectives**. This assessment will be presented in a peer reviewed narrative form, and will provide an evaluation of inventory data to identify:

- 1) critical data gaps to meeting Refuge management goals,
- 2.) station-specific water resource threats and needs include those which may be imposed by climate change, and
- 3.) make recommendations for options to address these gaps.

Resources from bibliography or other scientific journals/studies/reports can also be stored in the Service Catalogue (ServCat). Figure 1 shows a schematic of how this process works.

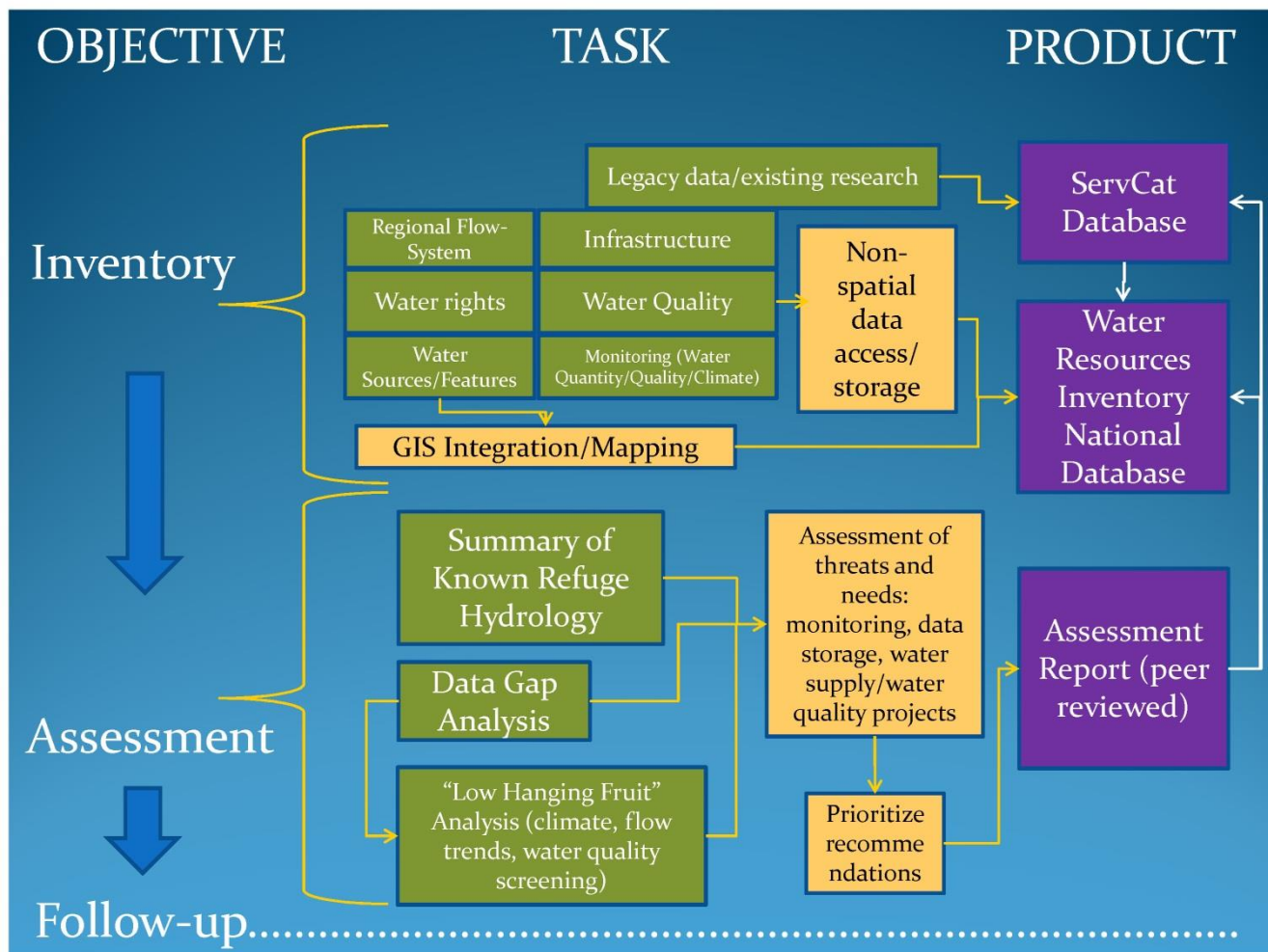


Figure 1. Schematic of the WRIA process

The WRIA has been developed with the intention of providing benefits at various scales to a variety of audiences. The WRIA database will provide the ability to query all or parts of the NWRS for specific parameters, such as the number of Refuges requiring water rights acquisitions or those that face water quality degradation.

The main benefits of the WRIA include:

- 1.) **Ease the transition of Refuge staff** in the event of turnover so that they can better understand Refuge water management and issues.
- 2.) **Allow easy and efficient access of hydrologic data** for Refuge staff, Service hydrologists, researchers, consultants to facilitate advanced hydrologic assessments.
- 3.) **Facilitate development and enhancement of regional and national water resources programs**, such as development of regional or national water monitoring programs that best fill data gaps identified in the WRIA.
- 4.) **Provide a list of needed site-specific hydrologic research and monitoring projects** based on critical needs, with time and costs required, to better prioritize projects for funding from regional and national sources.

- 5.) **Allow the ability to query Refuge needs and threats at the national level**, which will facilitate national level understanding of the status and trends of Refuge abiotic resources.

Two needs assessment reports have recently been completed for Region 8 I&M that included outreach to Refuges to learn more about general water resources issues of concern and requested assistance (U.S. Fish and Wildlife Service, 2012; WestWater Research LLC, 2014). The data collected from these efforts allows Region 8 to better gauge how important a WRIA might be to successful future operation of Refuges, based on the elements described above.

What Region 8 I&M Learned from the Pilot WRIAs

Seven Refuges have, or are in the process of receiving, a WRIA. These Refuges include Modoc NWR, Ruby Lake NWR, Kern NWR, Tulare Basin WMA, Ellicott Slough NWR, and Ash Meadows NWR; Pixley NWR WRIA is currently underway. The pilot process informed Region 8 I&M about the time and resources to complete a WRIA. A workflow process has been developed that allows Region 8 I&M to repeat the methods for other Refuges.

With current staff resources, WRIA reports can be expected to take about 5 months¹ for a Refuge with simple water resources issues, 7 months for a Refuge with moderately complex resources issues, and 9 months for a Refuge with very complex water resources issues. Efficiency can be gained by including multiple Refuges in the same report (if the Refuge is in the same or similar hydrologic setting; 2 months can be added for each additional Refuge included in the same report. This time is expressed for given resources (18 percent contribution from a GS-11/12 FTE and 82 percent contribution from a GS-9/11 FTE) and represents staff time not including other projects as assigned.

The most difficult and time consuming aspect of a WRIA is access and organization of adequate sources of data, especially when Refuges are surrounded by areas of complex water resources development or have complex water rights and water supply issues. When Refuges have little hydrologic data available, much time is spent researching alternative sources of information from outside sources such as USGS, state agencies, universities, and consultant reports. When Refuges have data that is poorly organized, much time is spent cleaning, organizing, and quality assuring data to ensure that it is satisfactory for summary analysis (and often, recommendations for improvement are made). When Refuges are located in areas with complex water resources issues such as groundwater overdraft, inter-basin transfers, urbanization, and many potential sources of contaminant, the time it takes to research available literature is increased substantially.

Scope and Purpose

Regional management have requested that a prioritization process be developed for Region 8 for development and completion of WRIAs that best meet Regional priorities and focus on Refuges where water resources issues are most critical. However, with limited staff resources and a large number of Refuges, comprehensive WRIAs cannot be developed for every Refuge to the same level that they were conducted for pilot Refuges. Furthermore, a WRIA might not be appropriate for all Refuges.

To better plan time and resources needed to complete WRIAs, a prioritization process is needed. Prioritization is needed to ensure that WRIAs are developed for Refuges that need it most. The scope of this white paper is to describe a process used to prioritize Refuges for future WRIAs. As more hydrologic information becomes available for Refuges and as

¹ It should be noted that all of the pilot Refuges can be considered to have moderate to complex water resources issues, therefore the estimate of time required to conduct a Refuge with simple water resources issues is unknown but estimated.

regional prioritize and as Refuge water resources issues change, this prioritization can be updated or modified as needed, because the process allows for flexibility.

Methods and Rationale

A ranking system was developed to prioritize WRIAs for Refuges based on determining goals and objectives for successful and efficient development of WRIAs for Refuges. The system allows for weighting so that changes the relative importance of different goals and objectives can be used to re-prioritize in the future.

Goals for successful WRIAs

Ideally: WRIAs should be developed for Refuges that have the following goals:

- 1.) **Maximize Need:** WRIAs should be prioritized towards Refuges that have significant water resources issues that affect the ability of the Refuge to carry out management objectives; the WRIA will benefit the Refuge significantly by helping to document complex problems, prioritize recommendations to address issues, and be a useful asset to Refuge management.
- 2.) **Minimize Difficulty:** Region 8 I&M should tackle WRIAs that are relatively easier to conduct to improve efficiency and make greater progress. Given the complexity of water resources issues, choose Refuges that are easier to complete with limited staff resources and time.

Determination of Objectives, and Ranking of How Well Refuges Meet Objectives Relative to Goals

A ranking system was developed to assign scores to each Refuge based on how much each Refuge met the characteristics above.

It should be noted that needs and difficulty objectives are often at odds with one another (for example, a Refuge with complex water supply issues indicates that the Refuge is in need of a WRIA, but also makes it difficult to complete a WRIA). However, by comparing the relative level of need and difficulty, it is possible to using relative group ranking to prioritize those Refuges that are in a “sweet spot”; in other words, those Refuges that have the greatest need, but are relatively easier to complete compared to other Refuges.

To work around this issue, for example, Refuges can be identified that are in the top third for greatest need. Among those, Refuges can be prioritized that have the least difficulty for completion first. This can also be done in the reverse; by group ranking difficulty and selecting the Refuges with the highest priority need within that group. Furthermore, if additional staff resources are obtained in the future, Region 8 I&M can down-weight difficulty to re-prioritize.

Objectives and sub-objectives were developed under each goal as described below, with a score range. Details about how each score was weighted and determined are explained in the next sub-sections of this report.

Need Scoring (aim to maximize)

- **N-1: Severity and complexity of water resources issues at the Refuge**, including the following sub-objectives:
 - N-1A: Refuge has complex or severe water supply issues (1-5)*
 - N-1B: Refuge has complex or severe water quality issues (1-3)*
 - N-1C: Refuge has complex or severe water policy/water rights issues (1-4)*
 - N-1D: Refuge has estimated high exposure or vulnerability to climate change (1-6)*

*Lower numbers are least complex/severe and higher numbers are most complex/severe

- **N-2 Refuge staff requested assistance in resolving or documenting issues**, including the following sub-objectives:
 - N-2A: Refuge staff requested a WRIA itself (1/0)*
 - N-2B: Refuge staff requested assistance with understanding water rights (1/0)*
 - N-2C: Refuge staff requested assistance with understanding water rights for neighboring properties (addressed in a WRIA) (1/0)*
 - N-2D: Refuge staff requested assistance with hydrologic monitoring (WRIs help to prioritize needed tasks to prepare for hydrologic monitoring) (1/0)*

*1 is yes and 0 is no

Difficulty Scoring (aim to minimize)

- **D-1: Minimal complexity in water resources issues at the Refuge**, including the following sub-objectives:
 - D-1A: Breadth and complexity of water supply sources are minimal (0-3)*
 - D-1B: Magnitude of water quality issues that impact the Refuge are minimal (0-5)*
 - D-1C: Water policy/water rights complexity/severity is minimal (1-8)*
 - D-1D: Complexity of water management system is minimal (0-4)*

*Lower numbers are least complex/severe and higher numbers are most complex/severe

- **D-2: Refuge water rights or water policy issues are relatively stable**, including the following sub-objective:
 - D-2A: Does Refuge have any pending water right applications, litigation, or adjudication? (0-1)*

*1 is yes and 0 is no

- **D-3: Refuge has easily accessible or minimally complex hydrologic monitoring data**
 - D-3A: Size of the Refuge watershed is small (it is more difficult to catalogue and use hydrologic monitoring data in larger watersheds; 0-4)*
 - D-3B: Refuge relies on groundwater, but is in a groundwater basin that is minimally complex, and/or water levels are well monitored (0-4)*
 - D-3C: Refuge manages or has access to well-organized and well-documented hydrologic monitoring data (0-3)*

*Higher numbers more complex hydrologic monitoring scenarios and/or poorly organized data

- **D-4: Refuge has well organized and well documented water data**
 - D-4A: Region has access to Refuge legacy data (special scoring, see next section)*
 - D-4B: Refuge has had previous analysis of contaminants issues (special scoring, see next section)*
 - D-4C: Refuge has relatively complete water rights documentation (0-4)**
 - D-4D: Refuge has a completed Comprehensive Conservation Plan (CCP, 0-1)***
 - D-4E: Refuge has water-related planning documents (special scoring, see next section)*

*Special scoring is based on the number of documents that meet this criteria, therefore higher numbers indicate better documentation

** Higher numbers indicate incomplete water rights documentation

***1 is no and 0 is yes

Normalization and Weighting

Because the ranking of different sub-objectives are on different scales, it is difficult or biasing to compare each ranking using the raw scores described above. Normalization is needed to place each sub-objective on one scale.

Scores for each sub-objective (ranked as described above) were normalized by the following equations:

$$\text{NOS} = (\text{OS} - \text{MinOS}) / (\text{MaxOS} - \text{MinOS}) \quad (\text{Eq. 1})$$

or

$$\text{NOS} = 1 - ((\text{OS} - \text{MinOS}) / (\text{MaxOS} - \text{MinOS})) \quad (\text{Eq. 2})$$

Where:

NOS: Normalized Refuge sub-objective score

OS: Refuge Sub-objective Score

MinOS: Minimum Refuge sub-objective score for all Refuges scored

MaxOS: Maximum Refuge sub-objective score for all Refuges scored

Equation 1 is used when it is desirable for the score to be maximized (for example, if one wants to select a Refuge which receives a higher score for having more severe water quality issues). Equation 2 is used when it is desirable for the score to be minimized (for example, if one wants to select a Refuge which receives a lower score for having less complex water rights issues).

Equation 1 was used on all scores for the “Maximize Need” Objectives, and most scores for the “Minimize Difficulty” Objective, with the exception of the scores for numbers of Refuge water-related documents in which a higher number indicated less difficulty in completing a WRIA. For these sub-objectives, Equation 2 was used so that all scores could be put on the same scale (higher scores indicate greater difficulty in completing a WRIA).

The final score is the sum of the NOS multiplied by a 2-level weighting factor. The first level weight is used to weight the objectives as they relate to the goal. The second level weight is used to weight the sub-objective as it relates to the objective. Higher weights represent a greater level of importance of that objective or sub-objective compared to others in the same category. Each level of weight adds up to one. The sum of the total scores in each sub-objective are summed and then multiplied by the appropriate weight.

For the “Maximize Need” Objectives, a slightly greater weight was given to Refuge complexity than on whether a Refuge requested assistance. This is because of the recognition that Refuges may not fully realize the benefits of a WRIA until the process is completed. Within N-2, a greater weight was given toward Refuges who requested a WRIA than the other objectives. If Refuges want a WRIA, they are more likely to gain benefits through working cooperatively with Region 8 I&M to complete the project.

For the “Minimize Difficulty” Objectives, a greater weight was given to Refuge complexity than other objectives. This is because it was recognized that this factor contributed most greatly to delays in completing the pilot WRIAs. Even if Refuge documentation is satisfactory, numerous water resources issues surrounding the Refuge will cause delays in literature search and summary, and processing and analysis of hydrologic data.

Table 1. Weights for goals, objectives, and sub-objectives used to rank and prioritize Region 8 Refuges for completion of WRIAs

Goal	Objective	Level 1 Weight	Sub-objective	Level 2 Weight
Refuge has a need for a WRIA	N-1:	0.6		
			N-1A	0.25
			N-1B	0.25
			N-1C	0.25
			N-1D	0.25
	N-2	0.4		
			N-2A	0.5
			N-2B	0.15
			N-2C	0.15
			N-2D	0.2
WRIA is minimally difficult to complete	D-1	0.4		
			D-1A	0.25
			D-1B	0.25
			D-1C	0.25
			D-1D	0.25
	D-2A	0.2		
			D-2A	
	D-3	0.2		
			D-3A	0.25
			D-3B	0.25
			D-3C	0.25
	D-4	0.2		
			D-4A	0.2
			D-4B	0.2
			D-4C	0.2
			D-4D	0.2
			D-4E	0.2

Methods and Sources Used to Determine Scores for Each Objective

It is possible to determine scores for each objective for each Refuge based on knowledge and experience alone. However, use of explicit scoring, based on previously collected data, reduces subjectivity and allows for increased transparency in communication of decisions.

Therefore, wherever possible, explicit scoring methods were used to assign scores to sub-objectives described above. Scores were computed as based on specific criteria identified to measure how well the Refuge met the sub-objectives. Sources of scores are explained for each section.

Need Scoring (aim to maximize)

N-1: Severity and complexity of water resources issues at the Refuge

N-1A: Refuge has complex or severe water supply issues (1-5)

Score criteria:

Score of 1: Refuge does not rely on surface water or groundwater to meet Refuge goals and objectives

Score of 2: Refuge may rely on surface water or groundwater to meet some Refuge goals and objectives, but this water supply occurs naturally without the need to divert or pump water. Refuge has enough water to meet Refuge needs.

Score of 3: Refuge is dependent on diverted water supply to meet Refuge goals and objectives (diverted water impacts 1-3 resources of concern (ROC), **and** has enough water to meet Refuge needs

Score of 4: Refuge is heavily dependent on diverted water supply to meet Refugees goals and objectives (impacts 4 or more ROCs), **and** has enough water to meet Refuge needs

Score of 5: Refuge is heavily dependent on diverted water supply* to meet Refugees goals and objectives (impacts 4 or more ROCs), **or** currently does not have enough water at the right times of year to meet Refuge needs, or doesn't know if they have enough water to meet Refuge needs.

*Diverted implies an external source of water (surface water that is diverted or groundwater that is pumped) that is acquired through a water right or a conveyance, and/or through a pumped well.

Sources of data used: Results were obtained from responses to survey questions 1, 7, and 62 from WestWater Research LLC (2014)

N-1B: Refuge has complex or severe water quality issues (1-5)

Score criteria:

Score of 1: Refuge does not have any water quality concerns

Score of 2: Refuge has 1 or more distinct* water quality concerns, but none are directly related to an ROC**, **or** Refuge does not have any water quality concerns, but has regulatory concerns.

Score of 3: Refuge has 1-2 distinct water quality concerns, 1 or more of which are directly related to an ROC **but** there are no regulatory issues, however.

Score of 4: Refuge has 1-2 distinct water quality concerns, 1 or more of which are directly related to an ROC, **and** has regulatory issues with water quality

Score of 4.5: Refuge has 3 distinct water quality concerns, all of which are directly related to an ROC, **but** does not have regulatory issues with water quality

Score of 5: Refuge has 3 distinct water quality concerns, all of which are directly related to an ROC, and has regulatory issues with water quality

*Distinctness of water quality concerns was evaluated independently for each Refuge based on judgment. Refuges may have listed more than one water quality concern that was related to the same problem. For

example, a Refuge may be concerned with eutrophication and contamination from pesticides, both of which are related to agricultural runoff. Agricultural runoff is a distinct water quality concern.

**ROCs were generally assumed to mean any biological objective for the Refuge, and not needs for drinking water for the bunkhouse (for example).

Sources of data used: Results were obtained from responses to survey questions 65 and 66 from U.S. Fish and Wildlife Service (2012).

N-1C: Refuge has complex or severe water policy/water rights issues (1-4)

Score criteria:

Criteria used to determine scoring was based on whether the Refuge had one or more of the following characteristics:

- Identified the existence of state-issued water rights
- Identified the existence of contractual or other water supply agreements
- Identified the importance of applied/diverted water to Refuge ROCs
- Identified that the Refuge does not understand or is not receiving full water entitlement
- Identified the need for additional water to meet Refuge goals

Score of 1: Relevance and severity of none: none of the criteria above apply

Score of 2: Relevance and severity of low: only one of the criteria above apply

Score of 3: Relevance and severity of moderate: two to three of the criteria above apply

Score of 4: Relevance and severity of high: four to five of the criteria above apply

Sources of data used: Relevance scores were obtained from Table 17 in WestWater Research LLC (2014)

N-1D: Refuge has estimated high exposure or vulnerability to climate change (1-6)

Score criteria and data sources used:

Total score is the sum of the following.

1.) Vulnerability to climate change from Magness et al. (2011):

Score of 1: Refuge is documented as having low vulnerability to climate change

Score of 2: Refuge is documented as having medium vulnerability to climate change

Score of 3: Refuge is documented as having high vulnerability to climate change

2.) Concerns of impacts related to climate change from U.S. Fish and Wildlife Service 2012 (responses to survey question 32):

Score from (1) plus 1: Refuge is concerned with impact of climate change on water quantity

Score from (1) plus 2: Refuge is concerned with impact of climate change on frequency of extreme storms

Score from (1) plus 3: Refuge is concerned with impact from sea level rise

N-2: Refuge staff requested assistance in resolving or documenting issues

N-2A: Refuge staff requested a WRIA itself (1/0)

Scoring criteria and sources used: 1 is yes and 0 is no. The answer to this question was obtained from responses to survey question 52 in WestWater Research LLC (2014)

N-2B: Refuge staff requested assistance with understanding water rights (1/0)

Scoring criteria and sources used: 1 is yes and 0 is no. The answer to this question was obtained from responses to survey question 48 in WestWater Research LLC (2014)

N-2C: Refuge staff requested assistance with understanding water rights for neighboring properties (1/0)

Scoring criteria and sources used: 1 is yes and 0 is no. The answer to this question was obtained from responses to survey question 20 in WestWater Research LLC (2014)

N-2D: Refuge staff requested assistance with hydrologic monitoring (WRIAs help to prioritize needed tasks to prepare for hydrologic monitoring) (1-4)

Scoring criteria:

Criteria used to determine scoring was based on whether the Refuge had one or more of the following characteristics:

- Refuge has requested assistance with monitoring for water rights reporting*
- Refuge has requested assistance with monitoring to compute water budget**
- Refuge has requested assistance with monitoring for water quality**

Score of 1: Refuge has not met any of the criteria above

Score of 2: Refuge has requested assistance with one of the criteria above

Score of 3: Refuge has requested assistance with two of the criteria above

Score of 4: Refuge has requested assistance with all three of the criteria above

Sources of data used: *The answer to this question was obtained from responses to survey question 43 in WestWater Research LLC (2014). **The answer to this question was obtained from responses to survey question 50 in WestWater Research LLC (2014).

Difficulty Scoring (aim to minimize)

D-1: Minimal complexity in water resources issues at the Refuge

D-1A: Breadth and complexity of water supply sources are minimal (0-3)

Scoring criteria:

The score was obtained from a sum of the following. If the answer to these questions was “yes”, the Refuge received one point each.

Question worth 1 point: Does Refuge manage a shoreline or island Refuge that is highly affected by water levels in a lake or large body of water?

Question worth 1 point: Does Refuge rely on diverted surface water?

Question worth 1 point: Does Refuge rely on groundwater for biological management?

Question worth 1 point: If no to any of the questions above, does Refuge rely on riparian, flood-flow, or tidal processes?

Sources of data used:

Answers to questions were obtained from responses to survey questions 1, 7 and associated comments in WestWater Research LLC (2014), and review of Refuge CCPs and websites.

D-1B: Magnitude of water quality issues that impact the Refuge are minimal (0-5)

Scoring criteria and data sources used:

The same scoring criteria was used from N-1B.

D-1C: Water policy/water rights complexity/severity is minimal (1-8)

The score was obtained from a sum of the following.

Question worth 1 point: Does Refuge have contracts or agreements?*

Question worth 1 point: Does Refuge have water rights?**

Question worth 1 point for each entity: Number of entities involved in contracts or agreements***?

Sources of data used:

*Response to survey question 6 in WestWater Research LLC (2014). **Response to survey question 3 in the same source. ***Response to survey question 17 in the same source.

D-1D: Complexity of water management system is minimal (0-4)

Scoring criteria:

Score of 0: Refuge has a completely natural flow system

Score of 1: Refuge has some infrastructure but not much, and is connected to water sources (for example, Ellicott Slough NWR)

Score of 2: Refuge has substantial infrastructure, but is straightforward (for example, Pixley NWR)

Score of 3: Refuge has very complex infrastructure **or** has substantial infrastructure and is straightforward – **but** has a topographically connected water supply system (for example, Modoc and Ruby Lake NWR)

Score of 4: Refuge has a very complex infrastructure and a disconnected water supply system (for example, Sacramento or San Luis Complex Refuges)

Sources of data used:

Review of completed infrastructure maps, Refuge CCPs, and Refuge websites

D-2: Refuge water rights or water policy issues are relatively stable

D-2A: Does Refuge have any pending water right applications, litigation, or adjudication? (0-1)

Scoring criteria and sources of data used: 1 is yes and 0 is no. The answer to this question was obtained from responses to survey questions 11 and 13 in WestWater Research LLC (2014)

D-3: Refuge has easily accessible or minimally complex hydrologic monitoring data

D-3A: Size of the Refuge watershed is small (0-4)

Scoring criteria and sources of data used:

The preliminary region of hydrologic influence (RHI) was estimated for each Refuge. The RHI was determined by intersection of the Hydrologic Unit 12 (HUC-12, U.S. Geological Survey National Hydrography Dataset, <http://nhd.usgs.gov/>, accessed July 2012) and the Refuge boundary, and adding the area of all contributing upstream HUC-12s (including the intersecting HUC-12). The total RHI areas were ranked and separated in quartiles of distribution among all Refuges.

The score for RHI size was determined as follows:

0: Refuge does not have a relevant RHI because the Refuge is an island or small upland that does not contain any water bodies within the Refuge boundary.

Score of 1, 2, 3, or 4 for the first, second, third, or fourth quartile, respectively.

D-3B: Refuge relies on groundwater, but is in a groundwater basin that is minimally complex, and/or water levels are well monitored (0-4)

Scoring criteria:

Score of 0: Refuge is not using groundwater

Score of 1: Refuge is using groundwater, and is in a basin that is not in overdraft

Score of 2: Refuge is using groundwater, is in a groundwater basin that is in overdraft, and groundwater level data in the basin is fully monitored.

Score of 3: Refuge is using groundwater, is in a groundwater basin that is in overdraft, and groundwater level data in the basin is partially monitored.

Score of 4: Refuge is using groundwater, is in a groundwater basin that is in overdraft, and groundwater level data in the basin is unmonitored.

Sources of data used:

In California, basins in overdraft are identified as those with a “medium” or “high” priority under the California Statewide Groundwater Elevation Monitoring (CASGEM) program (http://water.ca.gov/groundwater/casgem/basin_prioritization.cfm, accessed November 2014). The priority ranking of groundwater basins also included an analysis of the sufficiency of groundwater level data in each basin. For Nevada and Oregon, a default score of 2 was used for Refuges that used groundwater, under the assumption that groundwater level data availability is better in those states, and that groundwater regulation policies in those states prevent overdraft from occurring.

D-3D: Refuge manages or has access to well-organized and well-documented hydrologic monitoring data (0-3)

Scoring criteria:

Score of 0: Refuge is conducting their own hydrologic monitoring and data is being stored in the WISKI system (managed by the Region 1/8 Water Resources Branch)

Score of 1: Hydrologic monitoring data is being collected within the Refuge boundary and stored by an agency with a known public server

Score of 2: Refuge has a mix of the previous two criteria

Score of 3: No entity is collecting hydrologic monitoring data at the Refuge **or** Refuge indicated that hydrologic monitoring data was being collected but no further notes about that data were provided (indicating that data might be very difficult to use) **or** Refuge indicated that hydrologic monitoring data was being collected and stored in Refuge records (indicating that data will likely need quality assurance before use)

Sources of data used:

Data on whether Refuges were conducting monitoring was obtained from survey responses to question 69 in U.S. Fish and Wildlife Service (2012). Data on how Refuges are monitoring water was obtained from survey responses to question 41 and 42 in WestWater Research LLC (2014).

D-4: Refuge has well organized and well documented water data

D-4A: Region has access to Refuge legacy data

Scoring criteria and sources of data used:

The score was computed as the sum of water-related documents in ServCat (<https://ecos.fws.gov/ServCat/>, accessed November 2014) after the year 1995.

D-4B: Refuge has had previous analysis of contaminants issues

Scoring criteria and sources of data used:

The score was computed as the year of the last Contaminant Assessment Process Report (CAP. https://ecos.fws.gov/cap/search/land_map#, accessed November 2014) minus 1990. If the Refuge has not had a CAP, no additional points were added to the score.

D-4C: Refuge has relatively complete water entitlement documentation (1-4)

Scoring criteria:

Criteria used to determine scoring was based on whether the Refuge had one or more of the following characteristics:

- Identified perceived completeness regarding water entitlement documentation as complete or somewhat complete
- Identified the existence of a formal water rights assessment for the Refuge
- Identified a perceived completeness of records contained within the Water Rights Evaluation Network (WREN) database.
- Identified existence of GIS data related to water entitlements
- Identified access to paper maps of water entitlements

Score of 1: Refuge has met four to five of the criteria listed above

Score of 2: Refuge has met two to three of the criteria listed above

Score of 3: Refuge has met only one of the criteria above

Score of 4: Refuge has met none of the criteria above

Sources of data used: Documentation scores were obtained from Table 17 in WestWater Research LLC (2014)

D-4D: Refuge has a completed CCP (0-1)

Scoring criteria and sources of data used: 1 is no and 0 is yes. A list of the CCP status was obtained from the Region 8 Planning Division in July of 2014.

D-4E: Refuge has water-related planning documents

Scoring criteria and sources of data used: The score is the number of water-related planning documents produced by or for the Refuge. The score was obtained from the responses to survey questions 1 and 3 in U.S. Fish and Wildlife Service (2012). However, it is not known at this time whether these plans were accessible.

Results

The individual scoring results from the scoring process described above are available in an excel spreadsheet associated with this document.

There was a general correlation between the relative need for a WRIA and the difficulty to complete (figure 2). This was not surprising because Refuges that need WRIAs most often have complex water resources issues that take substantial time to research and document.

It is recommended that Refuges with a general need for a WRIA be conducted first. Therefore, final Refuge need scores were binned into three tiers (greatest need, moderate need, and least need), whereby the Refuges with scores of 0.66 or higher were considered to have the greatest need.

Difficulty scores were then summarized within each need group to determine a recommended priority order for Refuge WRIAs in each tier. The recommended priority order is for Refuges with the greatest need and least difficulty within that group be conducted first. Difficulty scores can be considered very complex if the score was above 0.66, moderately complex if the score was between 0.66 and 0.33, and easier if the score was less than 0.33.

Efficiency can be gained by conducting WRIAs for Refuges in similar hydrologic settings; such as Sacramento, Delevan, Colusa NWRs, San Luis and Merced NWRs, and Lower Klamath and Tule Lake NWRs. Therefore, if a Refuge had a ranked priority in Table 2, it was also recommended to do a WRIA for another Refuge if that Refuge occurred in a similar hydrologic setting; even if the priority ranking was lower.

Because of the substantial amount of time it will take to complete WRIAs, priority ranking was only conducted for Refuges in the Tier 1 group. By the time those Refuges are complete, new information will likely be available which can be used to update the prioritization results to reflect current situations.

Schedule

With current resources, it is estimated that completion of WRIAs in Tier 1 (including those Refuges in other Tiers that can be grouped with Refuges in Tier 1 because the Refuges are in similar hydrologic settings) will take 289 staff weeks (72.25 staff months), with 35 percent contribution from a GS 11/12 FTE and 65 percent contribution from a GS 9/11 FTE, and not including other projects as assigned. This also does not include efficiencies gained from conducting portions of the WRIA for other Refuges through other projects (water entitlement assessments, infrastructure maps, climate change assessments), and therefore the time required could be lessened through these activities.

Table 2. Recommended priority for conducting WRIAs based on need and difficulty

Priority Tier	Priority	Refuge	WRIA Difficulty Score	WRIA Need Score	Need and Difficulty Combined
Tier 1	1	SACRAMENTO NWR	0.47	0.69	Greatest Need and Moderately Complex
	2	STILLWATER NWR	0.48	0.73	Greatest Need and Moderately Complex
	3	UPPER KLAMATH NWR	0.49	0.68	Greatest Need and Moderately Complex
	4	BUTTE SINK WMA	0.53	0.79	Greatest Need and Moderately Complex
	1	DELEVAN NWR	0.54	0.72	Greatest Need and Moderately Complex
	5	STONE LAKES NWR	0.56	0.90	Greatest Need and Moderately Complex
	1	COLUSA NWR	0.57	0.75	Greatest Need and Moderately Complex
	6	LOWER KLAMATH NWR	0.63	0.67	Greatest Need and Moderately Complex
	7	SAN LUIS NWR	0.75	0.91	Greatest Need and Very Complex/Difficult
	8	SAN JOAQUIN RIVER NWR	0.75	0.93	Greatest Need and Very Complex/Difficult
Tier 2	TBD	CLEAR LAKE NWR	0.19	0.45	Moderate Need and Easier
	TBD	SAN DIEGO NWR	0.22	0.45	Moderate Need and Easier
	TBD	SAN DIEGO BAY NWR	0.27	0.49	Moderate Need and Easier
	TBD	DON EDWARDS NWR	0.27	0.41	Moderate Need and Easier
	TBD	TIJUANA SLOUGH NWR	0.28	0.58	Moderate Need and Easier
	TBD	SALINAS RIVER NWR	0.28	0.49	Moderate Need and Easier
	TBD	BITTER CREEK NWR	0.29	0.62	Moderate Need and Easier
	TBD	HOPPER MOUNTAIN NWR	0.31	0.65	Moderate Need and Easier
	TBD	DESERT NWR	0.35	0.40	Moderate Need and Moderately Complex
	TBD	SONNY BONO SALTON SEA NWR	0.44	0.52	Moderate Need and Moderately Complex
	TBD	KLAMATH MARSH NWR	0.45	0.61	Moderate Need and Moderately Complex
	TBD	MOAPA VALLEY NWR	0.50	0.36	Moderate Need and Moderately Complex
	TBD	FALLON NWR	0.51	0.46	Moderate Need and Moderately Complex
	TBD	PAHRANAGAT NWR	0.51	0.53	Moderate Need and Moderately Complex
	6	TULE LAKE NWR	0.52	0.58	Moderate Need and Moderately Complex
	TBD	SUTTER NWR	0.54	0.59	Moderate Need and Moderately Complex
	TBD	HUMBOLDT BAY NWR	0.58	0.50	Moderate Need and Moderately Complex
	TBD	SAN PABLO BAY NWR	0.60	0.46	Moderate Need and Moderately Complex
	TBD	NORTH CENTRAL VALLEY WMA	0.63	0.48	Moderate Need and Moderately Complex
	7	MERCED NWR	0.72	0.63	Moderate Need and Very Complex/Difficult
Tier 3	TBD	CASTLE ROCK NWR	0.09	0.08	Least Need and Easier
	TBD	BLUE RIDGE NWR	0.13	0.15	Least Need and Easier
	TBD	ANTIOCH DUNES NWR	0.14	0.00	Least Need and Easier
	TBD	MARIN ISLANDS NWR	0.15	0.15	Least Need and Easier
	TBD	COACHELLA VALLEY NWR	0.15	0.08	Least Need and Easier
	TBD	FARALLON NWR	0.15	0.17	Least Need and Easier
	TBD	ANAHO ISLAND NWR	0.16	0.29	Least Need and Easier
	TBD	BEAR VALLEY NWR	0.18	0.04	Least Need and Easier
	TBD	GUADALUPE-NIPOMO DUNES NWR	0.20	0.18	Least Need and Easier
	TBD	SEAL BEACH NWR	0.26	0.26	Least Need and Easier
	TBD	SACRAMENTO RIVER NWR	0.28	0.27	Least Need and Easier

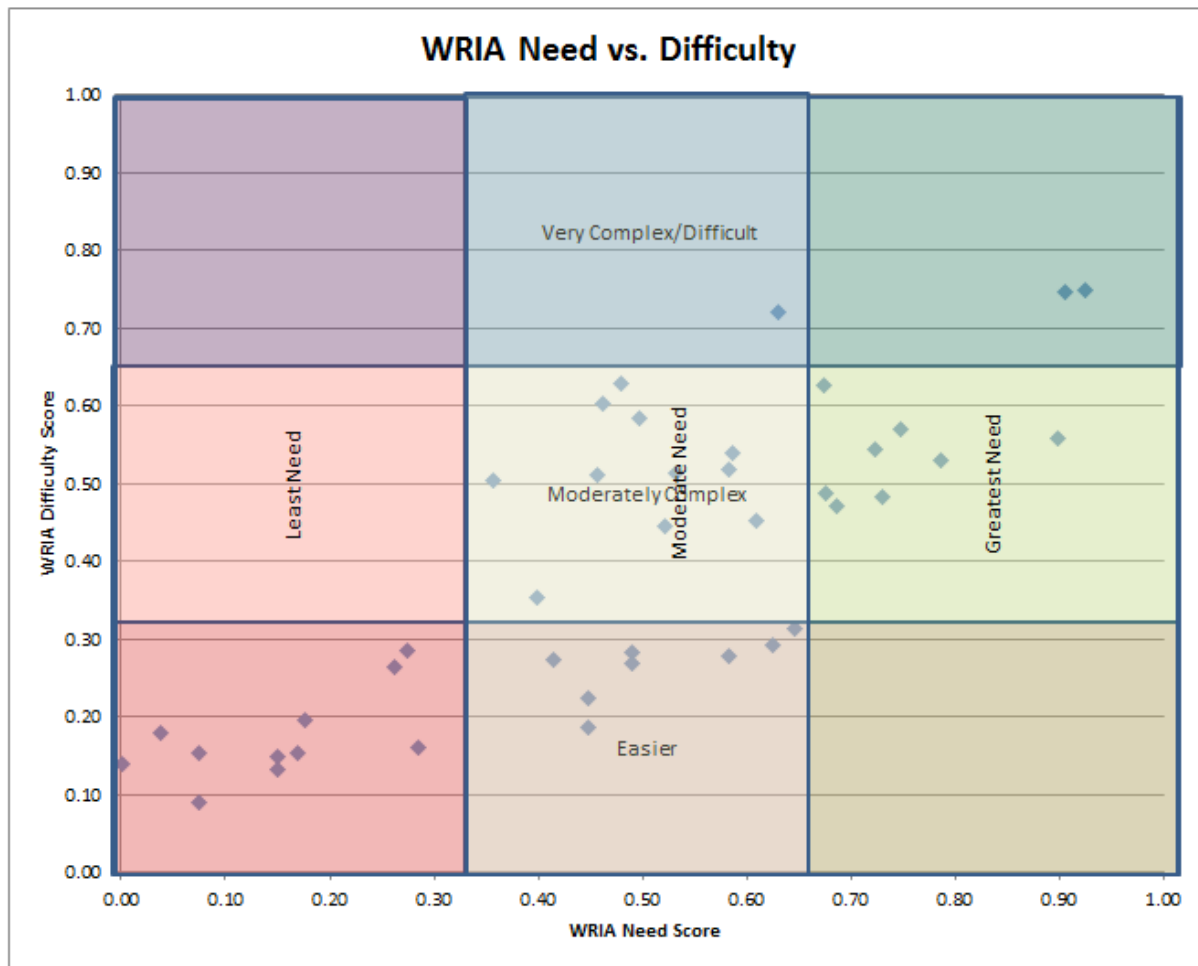


Figure 2. Scoring ranking Refuge need for a WRIA (WRIA Need Score) versus score ranking the difficulty it takes to complete a WRIA for each Refuge (WRIA Difficulty Score) for 42 Refuges in Region 8. Higher WRIA Need and Difficulty scores indicate greater need and greater difficulty, respectively.

Because the time required for other projects is not known at this time, a completion schedule cannot be developed with accuracy. However, it is estimated that with existing resources, it is reasonable to expect that WRIsAs for Tier 1 refuges can be completed in the next 5-6 years. This is based on an allocation of 65 percent time of the GS 9/11 FTE (34 weeks a year) and 30 percent time of the GS 11/12 FTE (18 weeks a year) dedicated solely to WRIA development in each fiscal year.

Table 3. Estimated time to complete top priority WRIAs. All Refuge rankings and tiers are listed in Table 2.

Tier	Refuge	Need and Difficulty Combined	Estimated Weeks¹
1	SACRAMENTO NWR ²	Greatest Need and Moderately Complex	15
1	STILLWATER NWR	Greatest Need and Moderately Complex	28
1	UPPER KLAMATH NWR	Greatest Need and Moderately Complex	28
1	BUTTE SINK WMA	Greatest Need and Moderately Complex	28
1	DELEVAN NWR ²	Greatest Need and Moderately Complex	15
1	STONE LAKES NWR	Greatest Need and Moderately Complex	28
1	COLUSA NWR ²	Greatest Need and Moderately Complex	15
1	LOWER KLAMATH NWR	Greatest Need and Moderately Complex	18
1	SAN LUIS NWR	Greatest Need and Very Complex/Difficult	32
1	SAN JOAQUIN RIVER NWR	Greatest Need and Very Complex/Difficult	32
2	TULE LAKE NWR ³	Moderate Need and Moderately Complex	18
2	MERCED NWR ⁴	Moderate Need and Very Complex/Difficult	32
Total			289

¹ Based on the following assumptions: 65 percent contribution from a GS 9/11 FTE and 35 percent contribution from a GS 11/12 FTE; moderately complex Refuges take 7 staff months to complete and very complex Refuges take 9 staff months to complete, not including time spent on other projects as assigned; WRIAs for Refuges take 2 additional months for every Refuge added to the report, as long as Refuge is in the same or similar hydrologic setting.

² Sacramento, Delevan, and Colusa NWRs can be grouped into one WRIA report

³ Tule Lake and Lower Klamath NWRs can be grouped into one WRIA report

⁴ Merced and San Luis NWRs can be grouped into one WRIA report

References

- WestWater Research LLC, 2014. Region 8 Water Entitlement Needs Assessment Survey Summary. Unpublished Report-30651. Boise, Idaho <https://ecos.fws.gov/ServCat/Reference/Profile/30651> accessed September 2014
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- U.S. Fish and Wildlife Service, 2013a, U.S. Fish and Wildlife Service Pacific Southwest Region – Refuges Inventory and Monitoring Annual Work Plan FY2013, Planning Report, 20 p. (available by request)
- U.S. Fish and Wildlife Service, 2012, Region 8 National Wildlife Refuge Inventory and Monitoring Needs Assessment Report, U.S. Fish and Wildlife Service Pacific Southwest Region – Refuges Inventory and Monitoring Initiative Report, 150 p. (available by request)